PHYLOGENETIC RELATIONS OF PINUS JEFFREYI AND PINUS PONDEROSA

N. T. Mirov

At present the phylogenetic relations of *Pinus Jeffreyi* Balf., Jeffrey pine, and *Pinus ponderosa* Laws., ponderosa pine (western yellow pine), are not accurately known.

Although fossil three-needle pine material occurs as far back as Jurassic, there is none of it which has been definitely assigned to either of the species under consideration. These species may be said to have practically no established fossil record, and it is not certain which of the two pines is geologically older. Long ago Lemmon (3) stated that *P. Jeffreyi* was not only an older form than *P. ponderosa,* but that it should be considered the ancestor of this comparatively younger species. Unfortunately Lemmon does not give any support for his statement. Later Simonsen and Rau (6) advanced a theory that pine species containing in their oleoresin saturated fatty hydrocarbons are probably geologically older than the pines containing unsaturated hydrocarbons, terpenes. It has been found by several investigators that oleoresin of *P. Jeffreyi* contains a saturated hydrocarbon, heptane, and no terpenes, while oleoresin of *P. ponderosa* contains a mixture of terpenes and no heptane. Additional information concerning the differences in oleoresin composition of the two pines may be found in a previous article by the author (5).

It has been suggested by Dr. Herbert L. Mason of the Department of Botany, University of California, Berkeley, that, from a distributional point of view also *P. Jeffreyi* is geologically older than *P. ponderosa.* It is an endemic species restricted almost entirely to California and associated with many other endemic plants. On the contrary, *P. ponderosa* has a much larger range that stretches far beyond the boundaries of the Jeffrey pine endemic group. Hence, it is concluded that *P. ponderosa* is the younger species. Moreover, Jeffrey pine is extremely stable, that is, it does not vary much, thus apparently exhibiting characteristics of racial senility. On the other hand, the extreme variability of *P. ponderosa* may be considered an indication of its relatively younger age.

The writer has been interested for some time in the chemical composition of seed oil of the two species. It has been found that the degree of unsaturation of the seed oil is much higher in *P. ponderosa* than in *P. Jeffreyi.* In general, oil of pine seed consists of triglycerides of unsaturated (oleic, linoleic and linolenic) acids, the amount of saturated compounds being very small. The degree of unsaturation of an oil is governed by the number of double bonds in its molecules. Oleic acid has one, linoleic two,

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and linolenic three, double bonds. With iodine an addition reaction takes place; one molecule of oleic acid reacts with two molecules of iodine, one molecule of linoleic with four, and one molecule of linolenic acid with six molecules of iodine. Iodine number is simply the percent of iodine absorbed by the oil. Analysis of oil samples extracted from seed of the two pines has shown that the iodine number of *P. ponderosa* varies between 147 and 154, the average of twenty samples being 151, while that of *P. Jeffreyi* is between 129 and 138, with 134 as an average for twenty samples. In the following discussion the writer will attempt to show how this difference in iodine numbers can be tied up with the phylogeny of the two pines under consideration.

Ivanov (2) has shown that oils of primitive plants had a high degree of saturation. As evolution of a certain branch of plant life progressed, unsaturation of the oils increased. According to Ivanov, probably the iodine numbers of plants of the Carboniferous and Permian had hardly reached 100–120. Progressively higher iodine numbers appeared later. Although there are many apparent contradictions to Ivanov's postulations, there is also ample experimental evidence to support the theory as a whole.

Ivanov's theory has found reflection in a recent communication by McNair (4) briefly abstracted in the American Journal of Botany. McNair agrees with Ivanov that the "average iodine numbers increase in value with the increase in evolutionary position" of the pines.

In the following table compiled chiefly from Ivanov's "Vegetable Oils," the increase in iodine numbers with evolution of gymnosperms is shown. The information concerning the geologic age of fossil gymnosperms (represented in the table by their nearest living equivalents) was supplied by Dr. Ralph W. Chaney, Professor of Paleontology, University of California, Berkeley.

Species	Geologic ages of most nearly related fossil gymnosperms	Iodine number	Remarks
Zamia integrifolia	Mesozoic	73	
Cycas revoluta	Mesozoic	94	
Ginkgo biloba	Eocene to Miocene	107	
Taxodium distichum	Eocene to Miocene	107	
Pinus monophylla	Miocene to Pliocene	108	Adams and Holmes (1)
Pinus sabiniana	Pliocene to Pleistocene	112	Author's data
Pinus radiata	Pleistocene	152	Author's data

From this table it is seen that in gymnosperms the evolutionary development was followed rather closely by increase of unsaturation of seed oils. The position of *Ginkgo* in this table is perhaps questionable, but it should be remembered that the

Ginkgoales had been developed as an independent branch of gymnosperms for a very long time. When the iodine numbers obtained for the two pines under consideration are compared with the general tendencies of iodine values shown in the table, the conclusion seems to be in favor of a relatively old age for *P. Jeffreyi.*

It appears from the foregoing that in addition to Lemmon's "hunch" of a more ancient origin of *P. Jeffreyi* as compared with *P. ponderosa,* we have now both biochemical and distributional evidence of the relative phylogeny of the two pines.

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ON THE IDENTITY OF CLAYTONIA NEVADENSIS WATSON

Carl. W. Sharsmith

Claytonia nevadensis was described by Watson in 1876 from a specimen collected by J. G. Lemmon in the Sierra Nevada of California. Since this first description, the species has been misunderstood repeatedly, mainly because of lack of knowledge or confusion concerning the nature of the underground parts. These parts consist of a tangled mass of slender, branching rhizomes with fibrous adventitious roots, not easily disengaged from the substratum, especially since the plant usually grows among rocks in shallow springs and runnels. The type of *C. nevadensis* Wats., (Pl. XXIX, fig. 1) upon which Watson's and later Rydberg's (N. Am. Fl. 21: 301. 1932) descriptions were based, and the type of *C. chenopodina* Greene (Pl. XXIX, fig. 2) have been examined. The underground parts of both types, especially of Greene's, are meagerly represented so that their partial or complete misinterpretation by these authors is readily understandable.

Watson, in the key to the treatment of his type material, vaguely described the underground system as composed of a "thickened caudex," while in the text he more correctly desig-